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(54) Wire cable anchor

(57) A metal wire anchor for protection system against rockfalls and avalanches, comprising a length (1) of metal wire cable bent to form a loop (10) at leat partially encased by a metal sheath (2), and a portion to be secured to the ground.

The metal sheath (2) is directly in contact with the cable (1) and provides a central portion (3) having a first thickness (∈1), and two end portions (4,5) having a second thickness (∈2) smaller than the former. The two end portions (4,5) are connected by two joining sections (6,7) having a progressively decreasing thickness, the portion (3) with said first thickness (∈1) extending over the whole loop (10), while the end portions (4,5) having said second thickness (∈2) extend along the cable sections that are parallel.

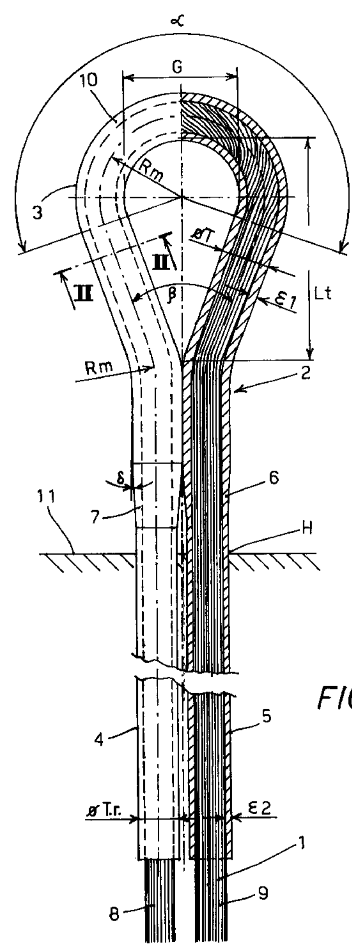

FIG. 1

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Description

[0001] The present invention relates to a wire cable anchor, particularly for anchoring protection systems against rockfall and avalanches. Anchoring devices of the above type are known and comprise a length of metal wire or rope formed as a loop or eyelet, and a portion to be secured in (cemented into) the ground, preferably a rocky ground, either directly in the rock or in a concrete block. Several components, such as wire cables, nettings and the like, provided for retaining the landslide mass or the avalanche are hooked to the loop.

[0002] A problem of such known wire cable anchors resides in their limited resistance to long term corrosion since the protection system, and particularly the anchor, can stay exposed to all weather conditions in mountain areas for many years.

[0003] Moreover the anchor portion emerging from the ground is subjected to stresses acting along variable directions, to deformations caused by large temperature changes, and to an environment favouring the corrosion (because of the presence of oxygen, water, acid soil). Conventional coatings and surface protection treatments, such as galvanization have proved to be completely ineffective with respect to the long life provided for the anchor.

[0004] EP-A-0 557 241, on which the preamble of claim 1 is based, discloses a spirally wound steel cable anchor, used in particular against rockfalls and avalanches, comprising a loop portion and a portion to be secured to the ground, wherein over the wire cable portion emerging from the ground there are fitted: a folded synthetic material sleeve extending at least over the region in which the loop is formed and in contact with the metal wire, and a metal tube or pipe, bent to conform to the shape of said loop and surrounding the synthetic material sleeve. The cable section cemented into the ground further comprises diverging portions of the synthetic material sleeve.

[0005] The synthetic material sleeve would protect the metal cable against weather influences, and the metal tube would protect the cable against wear and damages caused by the friction-generating movements of the suspended device supported by the anchor.

[0006] However the assembling of such a device is rather complicated and the resulting anchor exhibits a considerable stiffness difference between the portion jacketed by the metal tube and that encased by the plastic material tube only. The metal wire is not subjected to an axial tensile stress and the anchor is subjected to inconveniences such as the breaking of the plastic material sleeve caused by the mechanical stresses combined with those caused by temperature changes. Further, the two diverging sections of the plastic material sleeve at the grounding area can start a local crumbling of the concrete when the anchor is stressed along a direction that is not precisely axial, thus forming a passage to the water penetration.

[0007] It is an object of the present invention to overcome the above drawbacks and limitations of the prior devices and more particularly to provide a half-resilient (or partially elastic) anchor, in which the cable is subjected to tensile stresses acting along a substantially axial direction, said anchor being capable of linearly adjusting to progressive loads without causing such deformations that negatively alter the geometry and therefore the strength of the anchor, and without damaging the anchoring means connected thereto.

[0008] The invention accomplishes the above objects through a wire cable anchor as claimed in claim 1.

[0009] Additional advantageous features are recited in the dependent claims.

[0010] The invention will now be disclosed with more details with reference to a preferred but non-limiting embodiment, illustrated with reference to the attached drawings in which:

Figure 1 is a side view, partially in cross section, of an anchor according to the invention; and
Figure 2 is a transverse cross section along line II-II of Fig. 1.

[0011] With reference to the Figures, the anchor according to the invention comprises a length of metal cable 1 formed with galvanized strands. Preferably the cable or rope is formed by spirally wound strands, although an anchor according to the invention can include a rope formed with strands twisted about a (metal or textile) core strand. The length and the diameter of the cable are selected so that they can withstand the expected loads, taking into account the nature of the terrain. Indicatively, the diameter of the cable can be between 8 and 30 mm, depending on the applied load and the foreseen application, although these values are notto be meant as limiting.

[0012] The cable 1 is folded to form an eyelet or loop 10 to which nettings or other components (not shown) to be suspended are hooked. The portion shaped as a loop and the two portions immediately adjacent thereto are encased by a metal sheath 2 having a thickness that is not constant over the whole length thereof.

[0013] More precisely, the metal sheath 2 is directly in contact with the metal cable 1 and comprises a central portion 3 (corresponding to the loop) having a first thickness $\varepsilon 1$, and two end portions 4 and 5 having a second thickness $\varepsilon 2$ that is smaller than the former. The two end portions are smoothly joined to the central one by two tapered blending sections 6 and 7, i.e. having a progressively increasing thickness.

[0014] Although in general the values of $\varepsilon 1$ and $\varepsilon 2$ are selected depending on the load the anchor has to withstand, since the tube contributes, as a resisting structure, to bear the applied load, nevertheless the thicknesses $\varepsilon 1$ and ε satisfy the following relationship:

$$0.2\ \varepsilon 1 < \varepsilon 2 < 0.7\ \varepsilon 1.$$

[0015] Preferably, $\varepsilon 2$ is about equal to $\varepsilon 1/2$ for tubes having a medium thickness, and to about $\varepsilon 1/3$ for large thickness tubes.

[0016] The inclination or tapering angle δ of the joining sections 6 and 7 is comprised between 6° and 10°, preferably about 7°, and however the end zones of the joining sections have rounded edges. The angle β formed by the two approaching portions of the loop is 40° when the angle α of the loop curved portion is 220°.

[0017] Advantageously the metal sheath 2 is formed from a seamless steel tube (SS), having an ultimate strength larger than 40 kg/mm^2 and a yield strength larger than 24 kg/mm^2. Preferably the required configuration of the sheath his obtained by machining (turning) a metal tube having a constant wall thickness equal to $\varepsilon 1$. As an alternative, the tubular sheath could be extruded. The metal sheath 2 is protected both externally and internally against the mechanical wear and the weather corrosion by means of a hot zinc coating (applied by immersion).

[0018] The central portion 3 having a thickness $\varepsilon 1$ extends along the whole loop and the two portions immediately adjacent thereto in which the two portions of the tube (as well as the cable portions) are parallel. The tube end portions 4, 5 having a thickness $\varepsilon 2$ extend along the two cable sections that are parallel and subsequent to the joining sections 6 and 7. The two end portions 8 and 9 of the cable are uncovered. In use, the anchor is inserted into a concrete block or into a hole drilled in the rock 11 up to a point H that is located below the joining sections 6 and 7. In correspondence of such point, the two portions 4 and 5 of the metal tube are parallel and sligthly spaced from each other because of the reduced thickness of the tube.

[0019] The inner diameter $\varnothing T_{int}$ della sheath 2 is chosen so that the sheath adheres as tigthly as possible to the cable strands along the whole cable circumference, almost to form a single body therewith. This way, after being bent, the sheath exhibits neither deformations over the whole curved arc, nor diametral distorsions that could become failure starting points.

[0020] The inner diameter $\varnothing T_{int}$ of the tube is given by $\varnothing f$ + 1 mm (with a tolerance of ±0,1 mm) where $\varnothing f$ is the cable diameter, thus ensuring a minimum thickness of the zinc coating of 30/100, and the cable is introduced into the sheath with a very small play, or in case is sligthly forced.

[0021] The mean bending radius Rm and the outer diameter $\varnothing T_{est}$ of the tube satisfy the relationship:

$$1.6 < Rm/\varnothing T_{est} < 2.5$$

and preferably

$$1.8 < Rm/\varnothing T_{est} < 2.3$$

[0022] The angle α, i.e. the angular extension of the loop curved portion, is at least 215°, and preferably 220°. The next two portions of the tube are relatively short and substantially straight and become parallel to each other through a counterturn in each arm, this counterturn having the same bending radius Rm and extending over an arc of at least 17,5°, and preferably of 20°, to form a straight thimble.

[0023] With reference to the non-limiting embodiment shown in the Figures, the loop (inner) diameter or span G and the overall length Lt of the loop are given by:

$$G=2Rm-\varnothing T \text{ and } Lt= (Rm-\varnothing T/2) + (Rm-\varnothing T/2)/\text{sen}20°.$$

[0024] Preferably, to accomplish the function of protecting the cable against rust caused by condensation moisture, water and weather influences, the parallel arms of the sheath have a reduced thickness (preferably to 1/2 or 1/3 of $\varepsilon 1$) for a length not shorter than 8.5 $\varnothing T$, and in order to protect the cable in the portion cemented into the concrete, the length of the cemented portion is not shorter than 7$\varnothing T$.

[0025] Although the invention has been described with particular reference to a specific preferred embodiment, it will be appreciated that it is intended to cover all those modifications and equivalents that will be evident to the skilled in the art.

Claims

1. A wire cable anchor, particularly for protection systems against rockfall and avalanches, comprising a length (1) of metal wire cable bent to form a loop (10), at least partially encased by a metal sheath (2), and a portion to be secured in the ground, characterized in that said metal sheath (2) is directly in contact with said cable (1) and pro-

vides a central portion (3) having a first thickness ($\varepsilon 1$), and two end portions (4, 5) having a second thickness ($\varepsilon 2$) smaller than the former, the two end portions (4, 5) being connected to said central portion (3) by two joining sections (6, 7) having a progressively decreasing thickness, the portion (3) with said first thickness ($\varepsilon 1$) extending along the whole loop (10), while said end portions (4, 5) having said second thickness ($\varepsilon 2$) extend along cable sections that are parallel.

2. An anchor according to claim 1, characterized in that said thicknesses $\varepsilon 1$ and ε satisfy the relationship:

$$0.2\ \varepsilon 1 < \varepsilon 2 < 0.7\ \varepsilon 1.$$

3. An anchor according to claim 1 or 2, characterized in that the tapering angle (δ) of said joining sections (6, 7) is comprised between 6 and 10°, and the edges of the end zones of said joining sections (6, 7) are rounded.

4. An anchor according to the preceding claims, characterized in that both the inner surfaces and the outer surface of said metal sheath (2) are covered by a hot zinc coating.

5. An anchor according to the preceding claims, characterized in that the two tube portions to be cemented are parallel to each other.

6. An anchor according to the preceding claims, characterized in that:

$$\varnothing T_{in} = \varnothing f + 1\ \text{mm}$$

where $\varnothing T_{in}$ is the inner diameter of said sheath and $\varnothing f$ is the diameter of said cable (1).

7. An anchor according to the preceding claims, characterized in that the mean bending radius Rm and the outer diameter $\varnothing T_{est}$ of the sheath are bound by the following relationship:

$$1.6 < Rm/\varnothing T_{est} < 2.5$$

8. An anchor according to the preceding claims, characterized in that said loop comprises:

- a loop angle (α) of at least 215°;
- two substantially straight short sections; and
- a counterturn for each loop arm having a bending radius Rm and extending over an arc of at least 17.5°.

9. An anchor according to the preceding claims, characterized in that the length of the parallel sections of sheath with a reduced thickness is not shorter than 8.5 $\varnothing$T, and the length of the portion cemented in the concrete is not shorter than 7$\varnothing$T.

10. An anchor according to the preceding claims, characterized in that said metal sheath is obtained by turning a seamless steel tube (SS) having a thickness equal to $\varepsilon 1$.

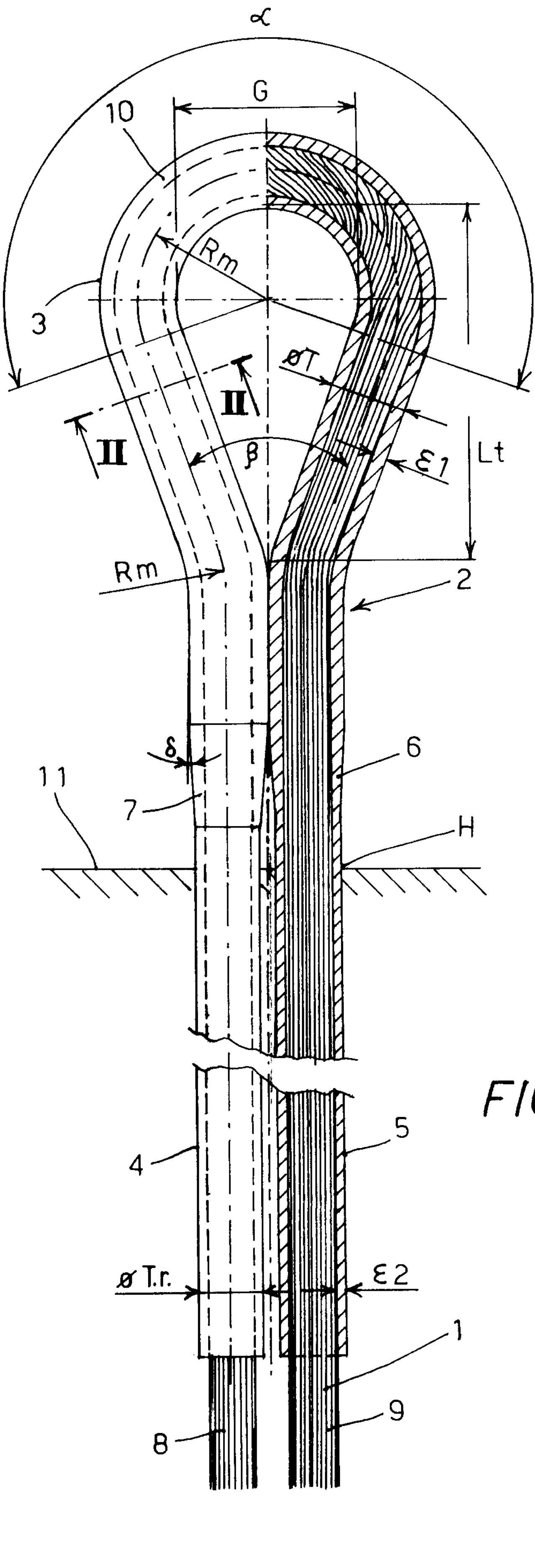

FIG. 1

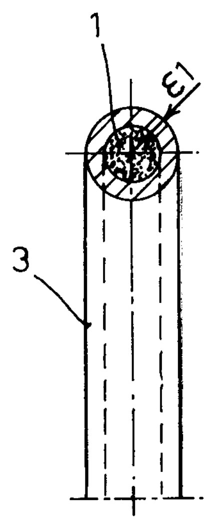

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 11 9408

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	EP 0 557 241 A (FATZER AG.) * page 2, line 29 - line 51; figure 1 * -----	1,4,5,8	E02D5/00 E01F7/04
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E01F D07B E02D F16G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 March 1998	Verveer, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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